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Simulating three-dimensional animation

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SIMULATING THREE-DIMENSIONAL ANIMATION

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TABLE OF CONTENTS

ASPECTS OF

THREE-DIMENSIONAL PERCEPTION

The problem dealt with in this thesis is that of creating three-dimensional appearing form, space and movement on a two-dimensional computer animation system. In order to understand what this means it is necessary to understand the differences between two and three-dimensional animation systems. The 3-D computer is programmed to understand the existence of the z axis, or depth. Points and shapes can be placed various distances away from the viewer, and the computer will apply to them the necessary rules of perspective. It will then translate these coordinates onto the two-dimensional screen. A two-dimensional system only understands motion and form on the x and y axis, so the task of applying the various rules of perspective and depth perception are left to the operator. With a sensitive application of the visual elements discussed here, this can be accomplished quite well.

The world appears to the average person as an intricate, three-dimensional environment. We take this for granted, but transcribing these surroundings onto a two-dimensional surface can be very complex. Our retinal image is flat, but even without our normal binocular vision the world does not appear flat. We rely on numerous visual cues to accurately comprehend dimensionality. Most of these cues were first noticed and analyzed by painters. Like the painted canvas,

the computer screen is limited to the monocular viewpoint, with the added advantage of movement to aid informing the sensation of depth.

Probably the most familiar visual signal is that of linear perspective. As objects move farther away, they appear to become smaller and closer together. This gives us an understanding of size and relative distance. Linear perspective is rendered with converging lines or foreshortened shapes, although a combination of the two gives the best results.

Related to linear perspective is detail perspective, sometimes referred to as a texture gradient.[1] Mathematically this is the same as linear perspective, but it deals with textures rather than edges. Good examples are leaves on a tree or grains of sand. With distance, the intervals between components and the components themselves become smaller. The textures become finer, gradually merging to form a uniform surface. Leonardo da Vinci called this the perspective of disappearance, and defined it as how objects in a picture "ought to be less finished in proportion as they are remote."[2]

In the heirarchy of visual cues, interposition has priority over perspective or any other. Interposition is when an object simply obstructs the view of another object and it thus perceived as being in front of it. Actually, we don't know that the rear object continues

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[1]Stanley Coren and Joan Girgus, Seeing Is Deceiving: The Psychology of Visual Illusions (Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1978), p. 131.

[2]Leonardo da Vinci, The Art of Painting (New York: Philosophical Library, 1957), p. 224.

behind its obstruction, but if its recognizability can be established at all through other signals then our mind will form a gestalt and assume its complete existance. Interposition is very familiar in everyday life since it is impossible to see any three-dimensional object in its entirety. Its totality is either obscured by other objects or by the intervening surfaces of the object itself.

Aiding in depth perception are certain properties of color. Most notable are the tendencies of an object, with great distance, to lose coloration and become predominantly bluish. Also the contrast between an object and its background becomes diminished. Incidentally, one uniform color that suggests great depths is black, because we readily assume it to be outer space.

More important than object's inherent color is the play of light over its surface. Shadows, reflections and highlights all give a sense of volume. A high contrast photograph is read only by interpreting the shadows. The use of shadows is further exemplified by looking at a flash photograph where all the normal shadow gradients have been obliterated, causing the shapes to look quite flat.

Shadows generally can be broken down into two types; cast shadows and attached shadows. A cast shadow falls onto a surface outside of the object while an attached shadow covers part of the perceived surface of the object itself. The position of a cast shadow can show both the distance an object is from what it is casting the shadow upon and the distance between the object and the observer. Attached shadows detail the modulation of a surface. Gradual transitions of tone represent a gently curving surface,

while sudden changes may represent an edge.

Chiaroscuro is an artistic interpretation or exaggeration of attached shadows. Here objects are rendered so that dark areas appear to recede and bright or highlighted areas appear to project towards the viewer.

Highlights and specular reflections combine with shadows to show an edge, and whether or not it is pointed towards the viewer. Edges that have one surface obscured do not reveal a highlight.

Incidentally, it is a convention to place the light source at the upper right, and our eye seems to expect that. Naturally the light should come from above, and perhaps our system of reading makes us more comfortable with light that goes from the left to the right.

A final cue to static depth is that of relative brightness. The brightness of a perceived object is a function of its distance from the light source, not its distance from the observer. With a local light source, variations in the intensity of the reflected luminosity will provide visual cues for relative spatial position. Objects illuminated by a distant source, such as the sun, show no change in brightness because they receive almost identical amounts of light. Regardless of this information, tests have shown that the brighter of two otherwise identical objects viewed in a dark surrounding was thought to be closer to the observers.[1]

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[1]Carolyn M. Bloomer, Principles of Visual Perception (New York: Van Nostrand Reinhold Co., 1976), p. 87.

Animation has a great advantage over static images in that the movement of objects synergistically confirms the visual cues of depth. Movement is created simply by applying a gradient of change to these visual cues.

The movement of related shapes falls into a heirarchy of dominance. Although the perceived events are effected by numerous details, certain generalizations can be made. What is seen as a figure will move, while what is seen as a ground remains stationary. When two objects near each other are displaced, the smaller appears to move. Similarly, with a difference in brightness, the dimmer of the two appears to move.

In order to demonstrate the functioning of these visual cues, an animated film was created on the Genigraphics 100c Computer. The following analysis of the film will be broken up into scenes. It is convenient to break up the film like this for several reasons. First, it is simply more manageable if while animating the number of frames in a sequence is kept to a limited number. Once a successful set of entries are completed they may be recorded on the disk. If one subsequently makes errors or there are problems with the machine, these previously recorded scenes are safe on the disk.

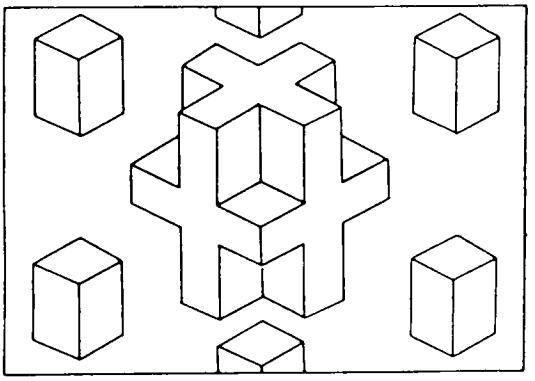
There are other reasons why it may be necessary to end a sequence, due to the particular structure of the Genigraphics animation program. If one wishes to add or subtract any objects, or change their overlay, a new scene must be started. A good example of why one would want to change the overlay of their objects can be seen in the analysis of scenes 29 through 33. It might be possible to begin an animation

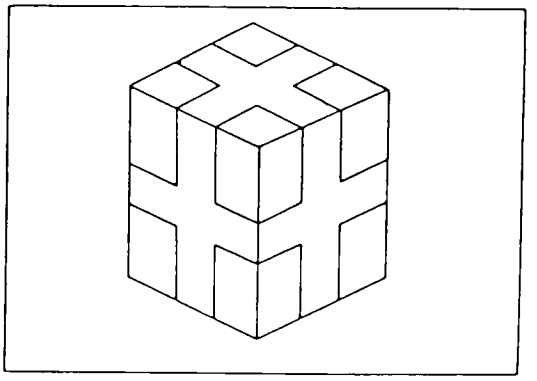
with all the objects one needs stored outside the visible frame, but this can lead to unnecessary complication and a more lengthy screen regeneration time, which slows down both creation and filming. All the breaks between scenes in this film involve changes in objects or overlays.

The appendix provides animation tables that divide each scene into entries and show much more technical information about each scene.

Scene 1: Group.ani

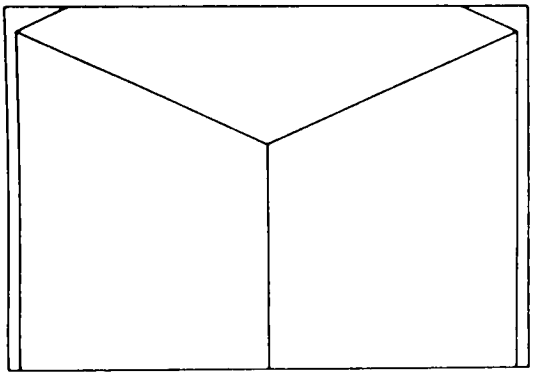
The film begins with a geometrical shape, that of a cube with other cubes cut out of its corners, fading in from a previously black and featureless screen. The shape is given dimensionality through simple light and shade, made particularly clear by placing the implied light source at the usual upper left. This orientation was maintained throughout the film. The smaller cubes that will complete the larger one then move in from positions in the surrounding space. This space is at first ambiguous as the cubes are identical in size, lighting and relative speed. However, one can shortly forsee the direction of their travel and their subsequent interposition with the main shape locks them into a concrete three-dimensional situation.

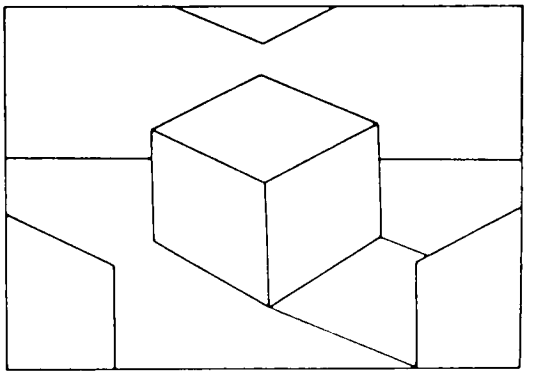




Scene 2: Cube.ani

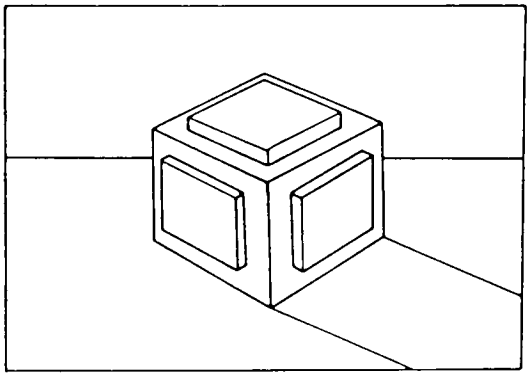
The cube assembled in Scene 1 is here replaced by a visually identical, but structurally different cube. It then appears to move closer to the viewer by growing larger. Since it is located in empty, black space this suggests no contradictions, but there no visual cues to suggest that it may not also be growing larger. In either case, when the cube fills the screen, it comes apart along the edges to reveal a scene behind it, situated here through interposition.

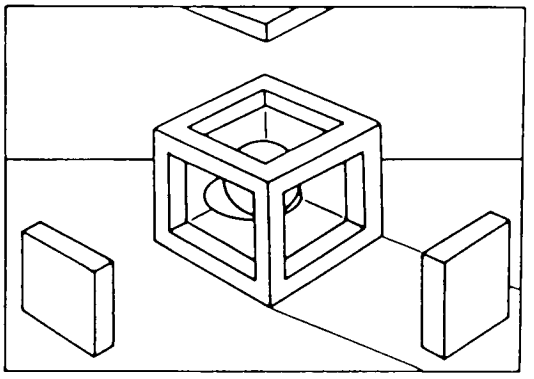




Scene 3: Cube2.ani

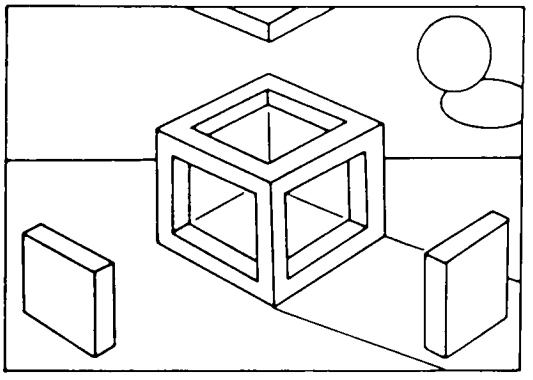
The cube revealed in this scene has a greater number of environmental cues than the previous one. It is resting on a horizontal surface that is revealed by the cast shadow and the facing edges of the cube are picking up some highlights. Behind it is a somewhat ambiguous edge representing either a horizon line or the corner of a room. Panels lift out of the cube showing it to be hollow and containing two spherical objects. They are rendered in chiaroscuro by creating a group of circles on top of each other and giving each circle a slightly different color, spaced regularly from the dark shadow color to white of the highlight.

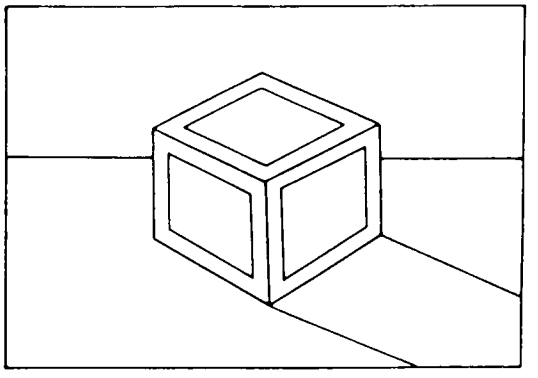




Scene 4: Cube3.ani

The two objects contained in the box then quickly move out through the top aperture and off the screen. The panels are then replaced forming an unbroken cube. This entails that the panels move over part of a side and under another part of the same side. However, the Genigraphics overlay only allows a particular shape to occupy a specific level. In order to create this without breaking the scene into two parts, interrupting the smooth motion, each side of the cube is rendered in two sections, and arranging them in the overlay solves the problem.

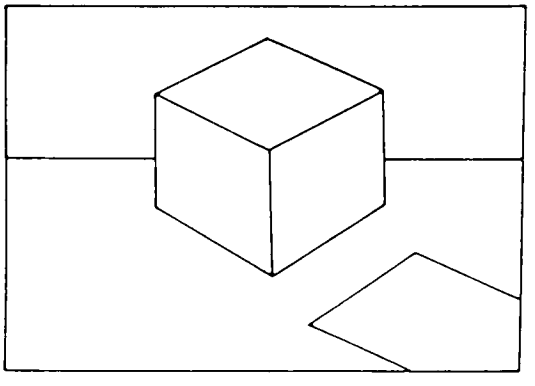


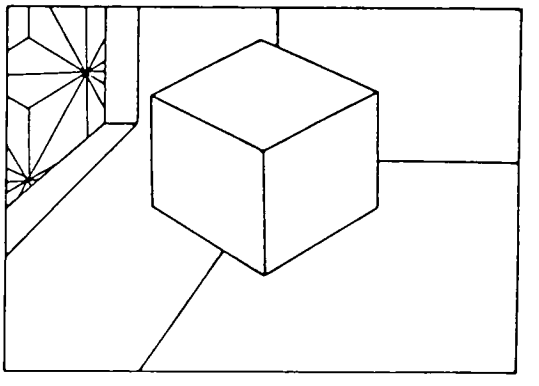


Scene 5: Cube4.ani

In this scene the box appears to lift off of the floor surface. This movement is clarified and defined by simultaneously separating the shadow from it. There is a slight inaccuracy in this part as the shadow should separate from the lightward side of the box rather than from the shadow side. However, since the overall movement is quite rapid, this is barely noticable.

The box then moves laterally out of a window. Actually, the distant background and box are stationary while the room alone moves. According to the heirarchy of figure-ground movement, the figure, or box, should appear to move. It does, but it would be much more convincing if perspective changes in the room and the background confirmed this action.





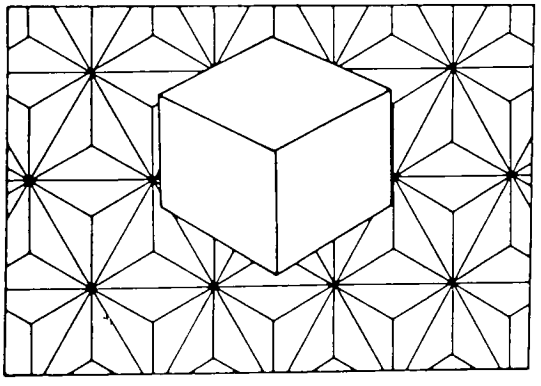
Scene 6: Geo.ani

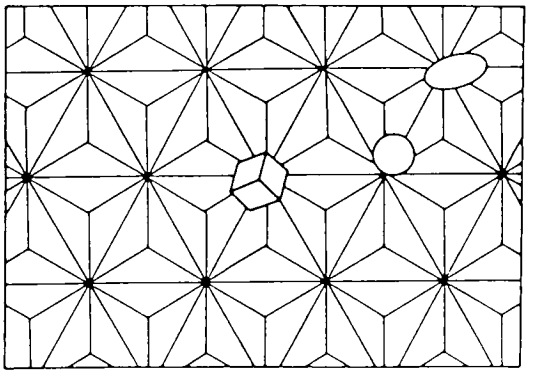
Here the scene begins with the box hovering over a complex, regular geometric surface. Since the surface has no recognizable qualities and the box is casting no shadow, it is impossible to judge the distance to the background or the relative scale without further cues.

After a moment, the background is revealed as being very distant when the box shrinks dorn to invisibility while traveling towards the geometric pattern. As it recedes it rotates. In order to maintain the illusion of a constant light source, the colors have to be continually transformed as it rotates.

The two spherical objects introduced in Scene 3 follow it immediately. They demonstrate a similar perspective changes as the box, but would support the illusion even better if they moved closer together as they neared the vanishing point.

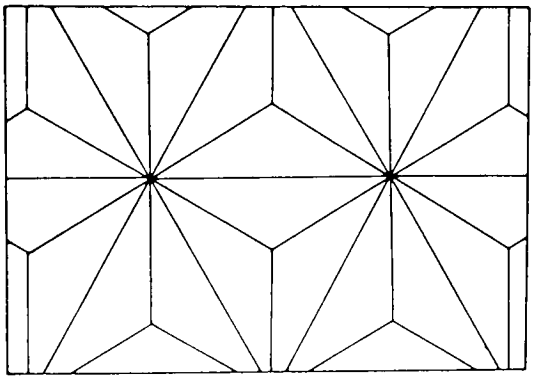
The three of them enter an opening created by placing a miniature version of Scene 7 behind a space in the pattern. The hole is revealed by changing the colors from the uniform pattern colors to those of Scene 7.

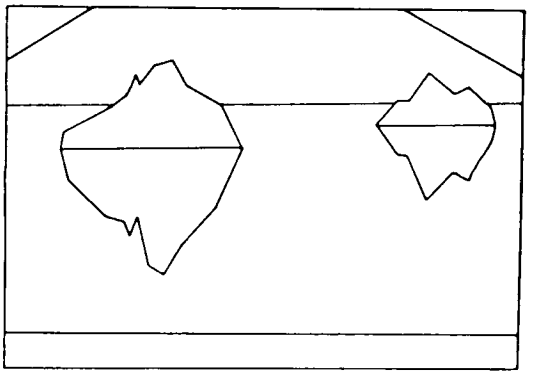




Scene 7: Island.ani

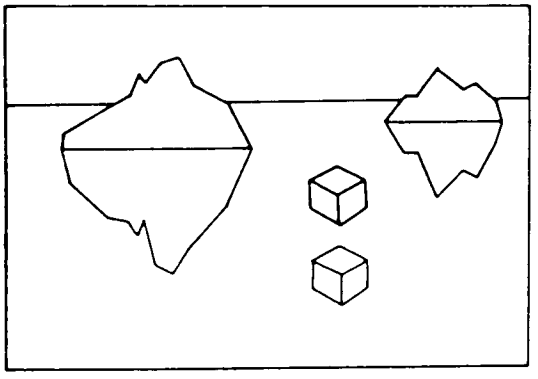
The viewer follows the objects through an opening in the geometric background. There is revealed an image of a frozen landscape with icebergs. Reflections in the ice help to establish spatial orientation while modulation in the blue background gives a sense of deeper space.

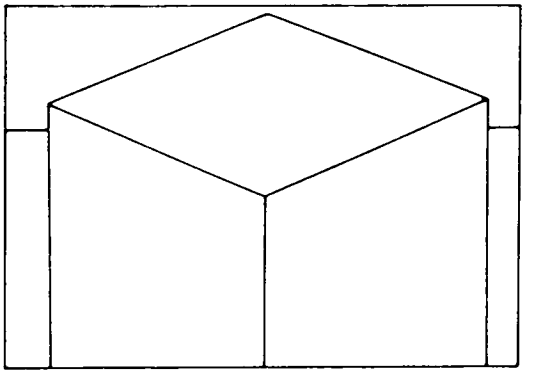




Scene 8: Island2.ani

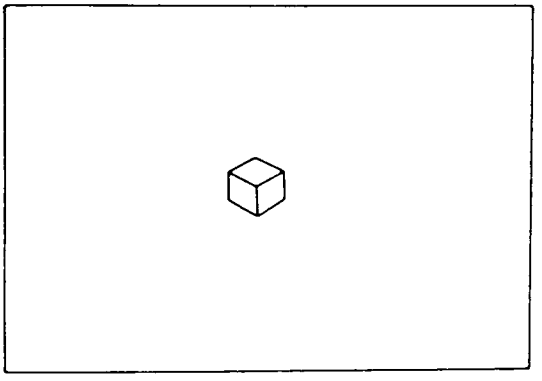
Here the large geometric background, now invisibly located off the screen, is removed to speed screen regeneration time. It begins with the cube seen earlier moving over the image of the frozen sea. Its distance above the ice is revealed by the position of its reflection directly below it. The cube then moves foreward and grows until its one side fills the frame with a solid color.

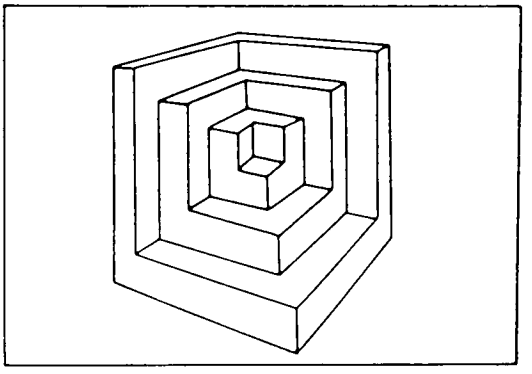




Scene 9: Boxes3.ani

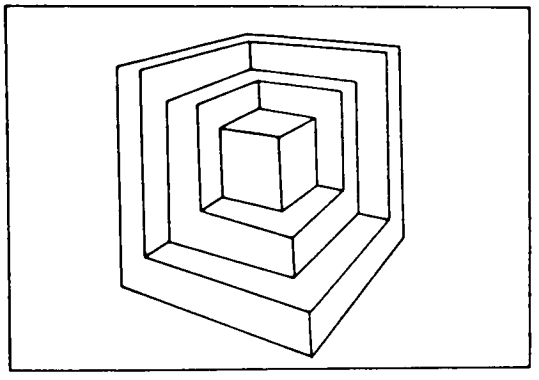
The ambiguous space of the single color left from Scene 8 is soon perceived as deep space as a minute cube rapidly moves to the foreground, growing as it does. A front section then lifts off the box, revealing a faceted interior. Although these parts are multi-colored, the application of light and shade is able to give them a sense of volume.

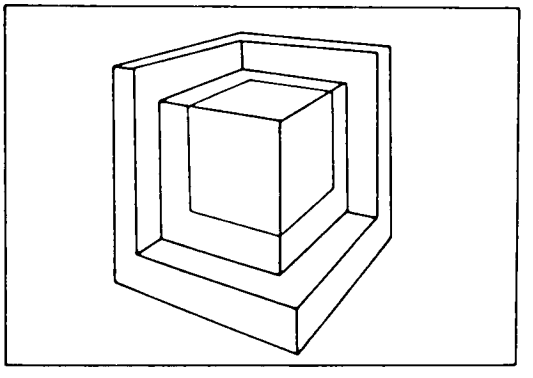




Scene 10: Boxes4.ani

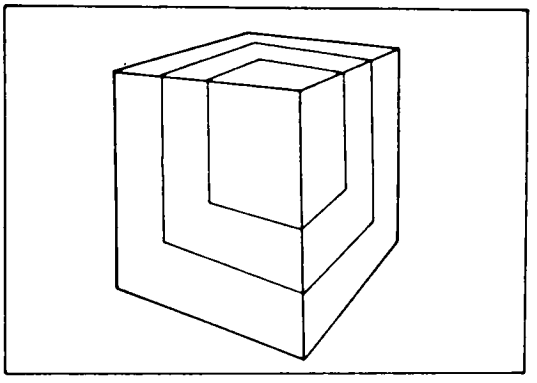
The interior steps of the cube begin to move and transform toward the eventual formation of a complete cube.

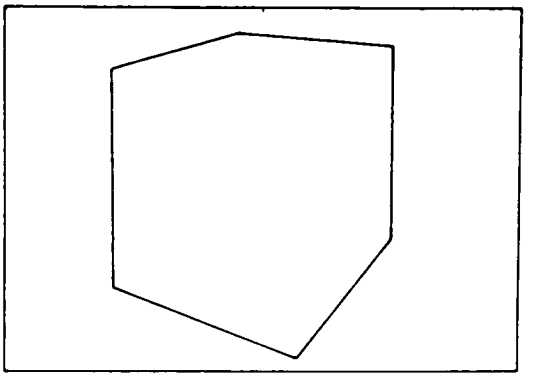




Scene 11: Boxes5.ani

Transformations continue to be applied to the interior until the complete cube is formed, with only bands of color suggesting its former configuration. These fade to a monotone revealing no three-dimensional cues.



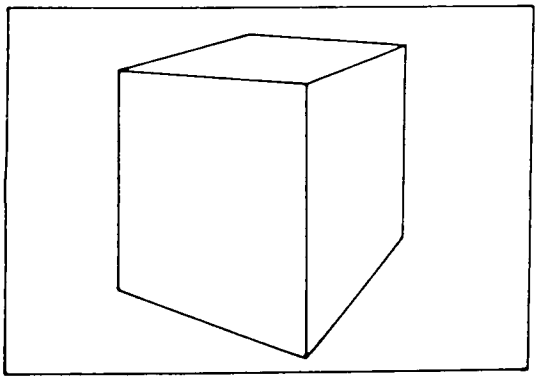


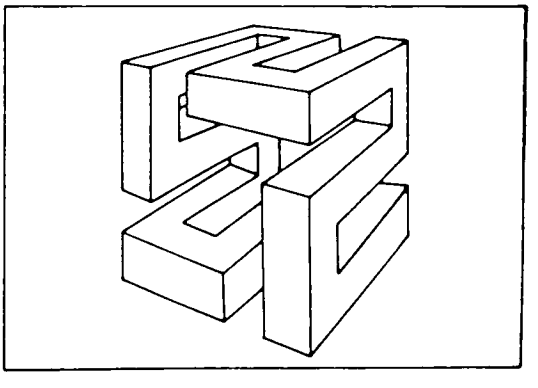
Scene 12: Lock.ani

The uniformly colored cube is here replaced with a similar appearing cube that is actually composed of many parts. Dimensionality is restored by coloring the cube with conventional shading. This illusion is dissolved when color changes alter the cube into a complex geometrical object.

When a group of objects are changing between a uniform color and a group of colors it is often preferable to use RGB rather than HVC color changes. HCV changes may appear to move around the color wheel and will sometimes take on a different intermediate hue. This would not be so bad, but when two colors are changing to a third one, they will occasionally take a different route around the color wheel creating some unexpected arbitrary color combinations. RGB color is a direct change and gives a smoother transformation.

After this new object is revealed through these color alterations, the view frames in, passing through an opening in the form and into dark, undifferentiated space.

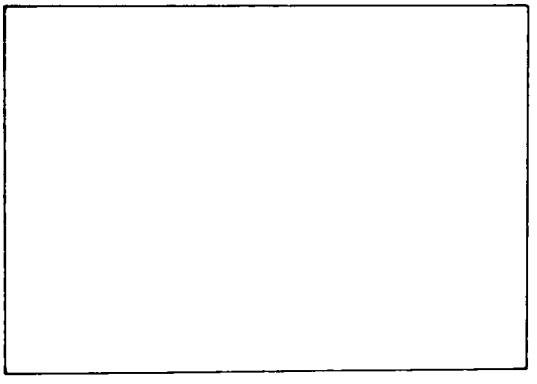


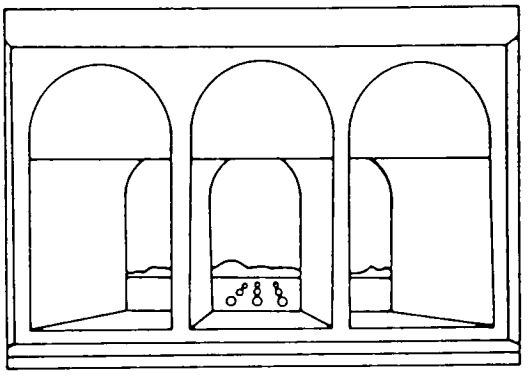


Scene 13: Arch.ani

From the previous darkness, a dark curtain appears to move up, revealing a landscape as seen through three arches. As it first begins its ascent, the steps before it lighten, suggesting light flooding in from outside. This feature is partly lost on the videotape as most of the steps are cut off by the frame.

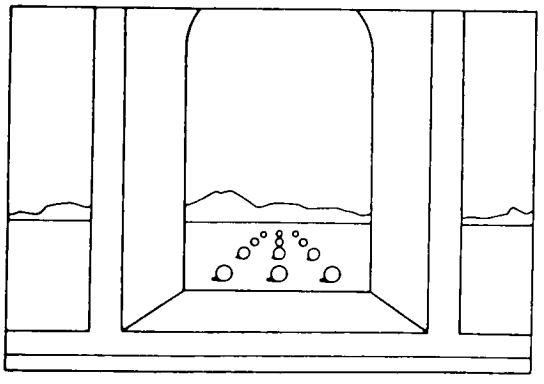
Variations on the interior tonality of the arches gives a good sense of depth and the play of light without using an overabundance of shapes.

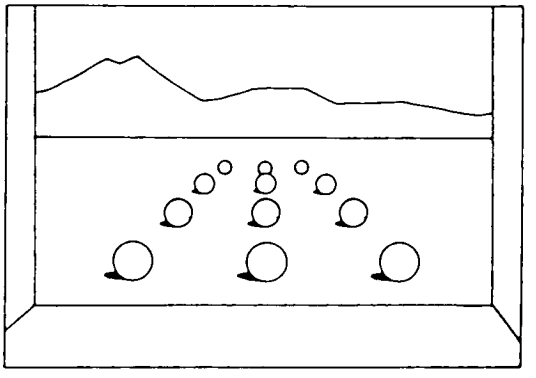




Scene 14: Balls.ani

The view then frames in through the arcade and into the landscape beyond. Although this approximates one-point perspective, it is actually more like moving the viewpoint closer to a perspective rendering on paper than moving through actual depth. As the nearer objects come forward, those most distant in the perspective scheme appear to come forward at the same rate. This could possibly be corrected by moving or transforming the objects while zooming.

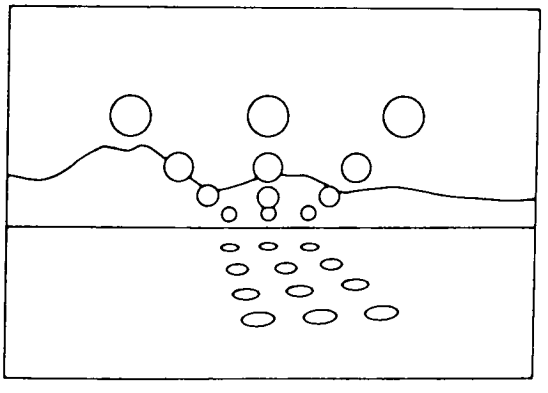


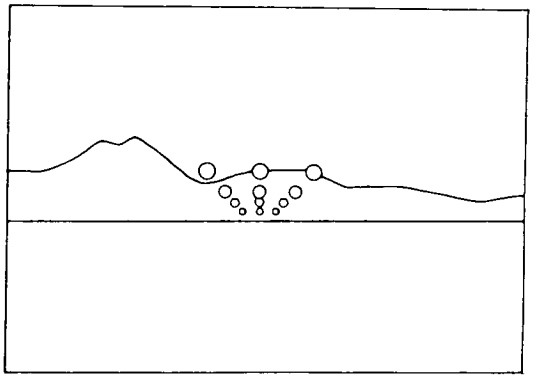


Scene 15: Balls2.ani

This scene begins with the arrangement of balls filling the screen. They are rendered with chiaroscuro and are perceived to be resting on the ground by the location of their shadows directly below them. The spheres then rise up in unison to a certain height above the ground and and then recede to disappear in the remote distance. As they ascend, their shadows move away and lighten to ground color. The color transformations were carried out at a constant rate, but but in order to obey the laws of perspective the shadows had to be moved different distances in correlation to their distance from the viewer, thus requiring separate entries for each row of shadows. HCV was used for these color changes, causing them to travel through some slightly warmer intermediate tones.

After the spheres have disappeared the view rises up and the sky darkens to the blackness of outer space.

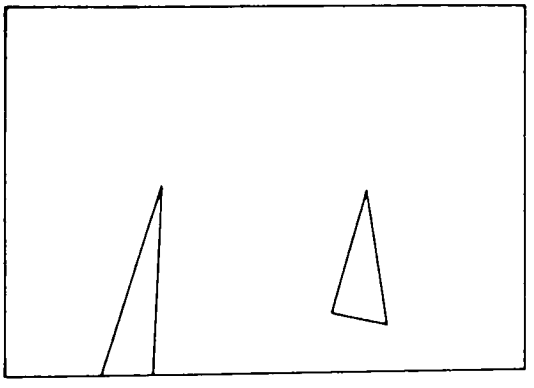


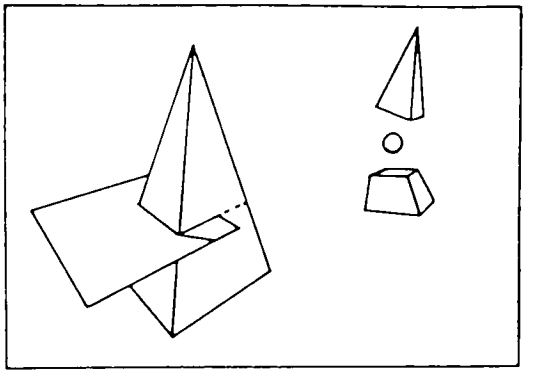


Scene 16: Pyra.ani

On to the screen from below travel two flat, two-dimensional appearing triangles. They are revealed to actually be three-dimensional by the perpendicular plane that cuts through them. The interposition of these shapes and the cast shadows gives dimension to what was previously perceived as having only two dimensions.

After being sliced in half, the bisected pieces slowly rotate away in space, with color changes revealing more of their form.

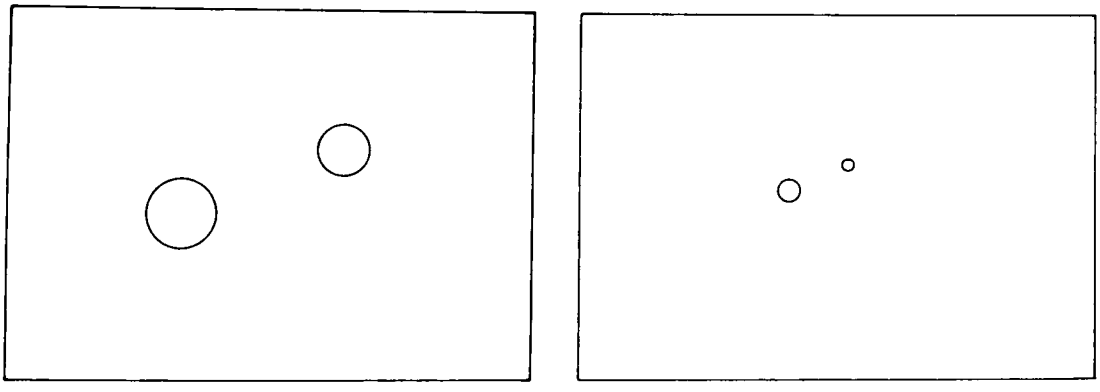




Scene 17: Blue.ani

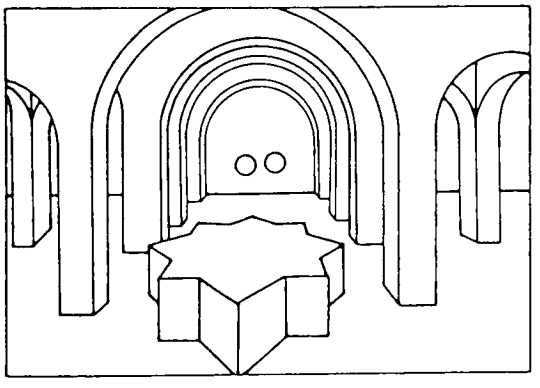
The two spheres that were left behind by the bisected pyramids begin to orbit around one another in a somewhat random fashion. It would appear less random if one of them remained stationary or if the perspective changes in size were greater.

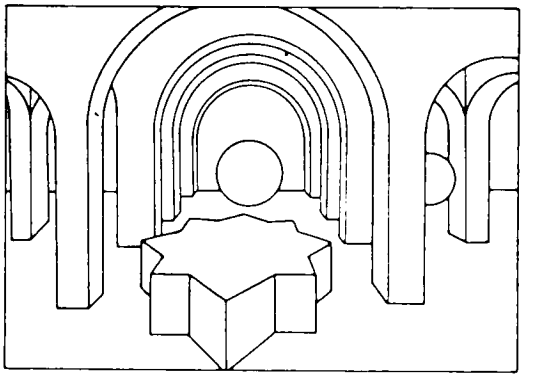
The spheres then diminish in size. It is at first not obvious whether they are shrinking or the viewer is moving backwards. This ambiguity is clarified in the next scene, where the viewpoint is seen moving backwards into its surrounding.



Scene 18: Altar.ani

This scene begins with framing out from the black space into the interior of a room. Then the spheres from the previous scene appear out of the vanishing point and travel through the room, thus strengthening the illusion that the camera moved backwards from outer space into the room. One sphere travels behind a row of columns. To create this illusion an extra row of columns had to be duplicated at the very top of the overlay for it to travel behind.

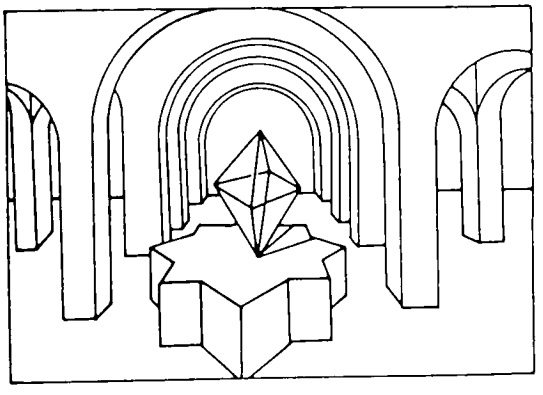


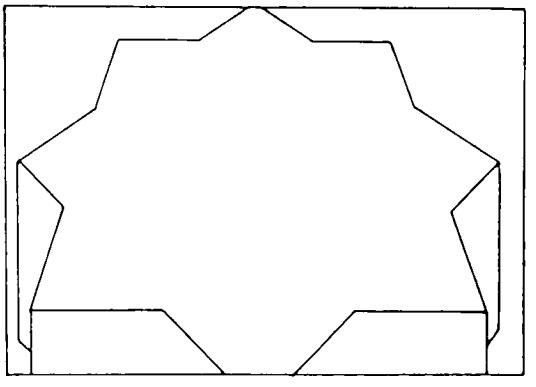


Scene 19: Altar2.ani

Here an amethyst appears from the same position in deep space that the spheres came from. Instead of passing through the room it stops over the star-shaped table. Although the gem seems to have qualities of transparency, it is created with opaque shapes as are all Genigraphics images.

Its position is strengthened by a shadow that appears on the table through a RGB color change. The shadow then fades as the amethyst shrinks to invisibility. The view then frames in on the table until its surface fills the screen with a uniform color.

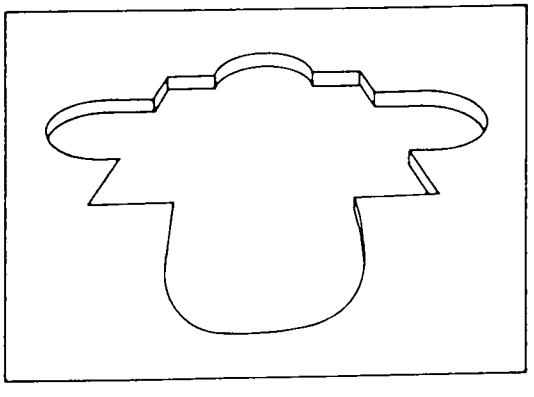


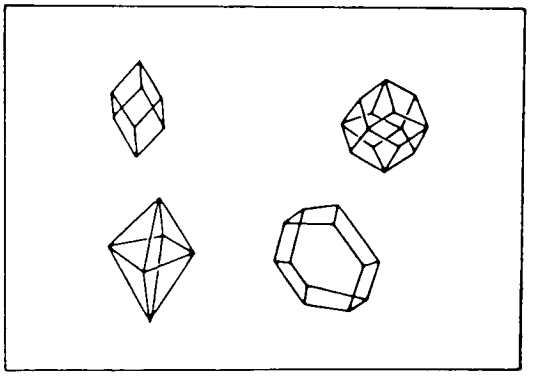


Scene 20: Pit.ani

After framing in on the surface of the table, the environment from the last scene is replaced with a different scene, presently colored identically to the surface of the table. Then a flat shape appears in blue through a color change. This is revealed as water in a pool when the water level goes down and the sides of the pool start to show. For natural interposition, various parts of the pool have to be in front of the ground and other parts must pass behind it. To create the correct overlay both the water shape and the surrounding ground had to be created out of numerous parts.

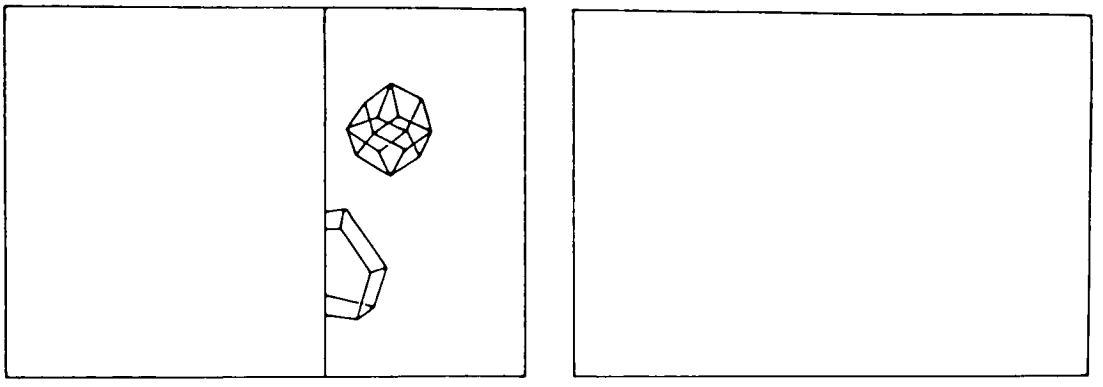
The water then uncovers four gems sitting on the bottom of the pool. This was achieved by covering each with a square shape that is the same color as the water. While the water is still going down, they are each moved down off of the gems. The view then frames in on the gems.





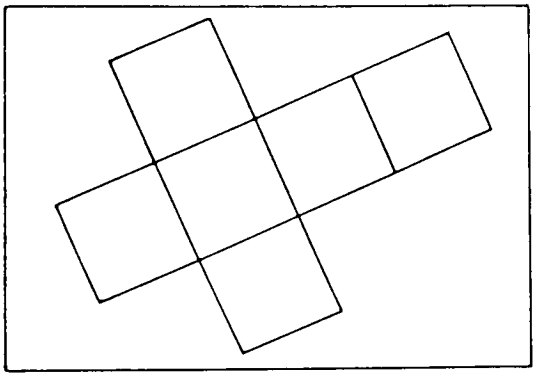
Scene 21: Pit.ani

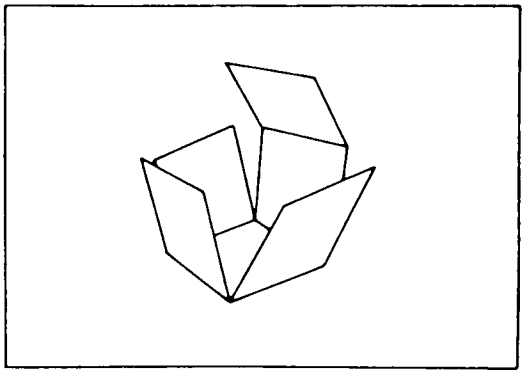
Here, through a shape transformation, a uniformly colored area moves across and obstructs the scene.



Scene 22: Fold.ani

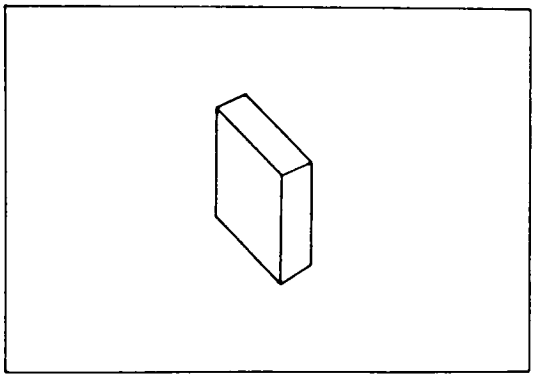
The shape is replaced with a different shape of the same color and the scene with the gems and pool is deleted. Framing out then reveals the shape, that of an unfolded box, as it revolves in space. Using sixteen entries of transform and color change, the shape appears to fold up into a box. Here the overlay is again important to give the correct interposition.

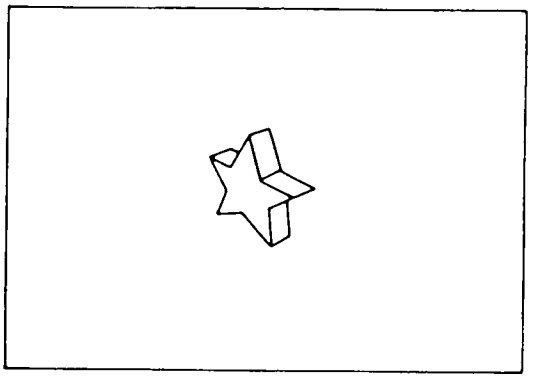




Scene 23: Star.ani

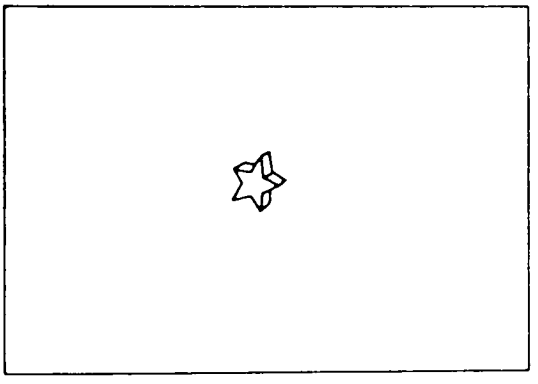
The completed box is here replaced with an identical box differing only in the addition of several vertices along each side. By moving these vertices the box is then transformed into a three-dimensional star shape.

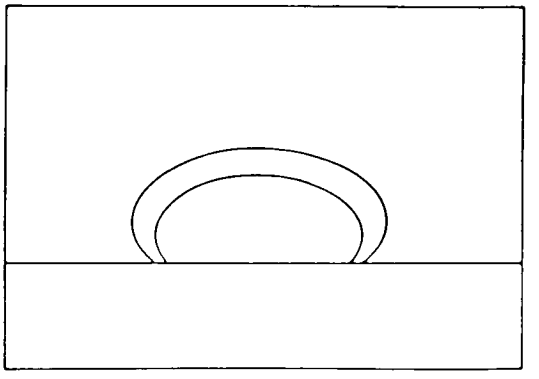




Scene 24: Flash.ani

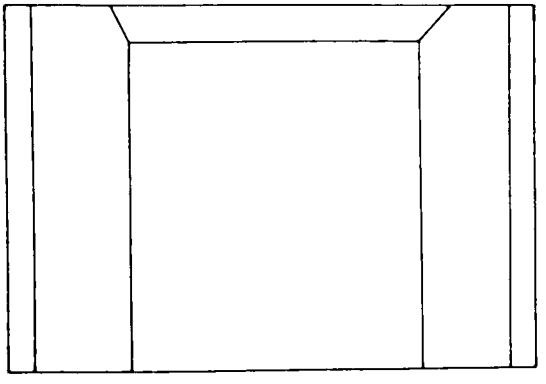
In this scene the star changes through HCV to yellow as it shrinks, apparently moving off towards the horizon. After it disappears at the vanishing point, a flash appears, formed by two ellipses. The smaller is in front and colored like the background and the larger is behind and shaded similarly but changes to bright red and then fades to black.

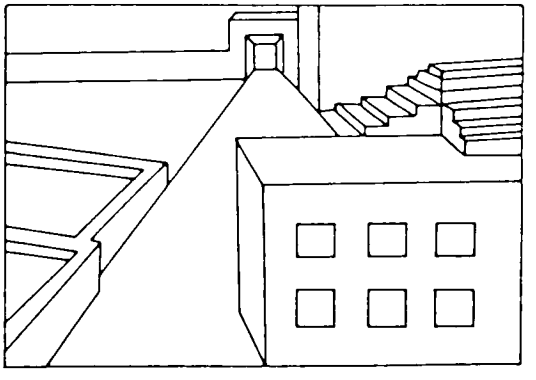




Scene 25: Court.ani

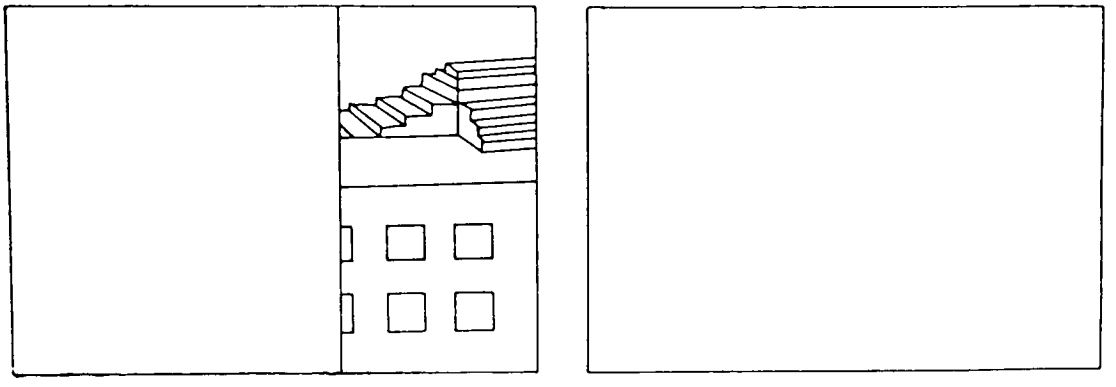
The black sky is here replaced by a scene of buildings, framed in on the black sky seen through a doorway. Then the view frames out, revealing the complete environment. When framed all the way in, the doorway was too small and its sides were still showing when the screen needed to be totally black. This was remedied by starting the scene with them moved out slightly to either side. They are then replaced in the first few frames of the zoom out.





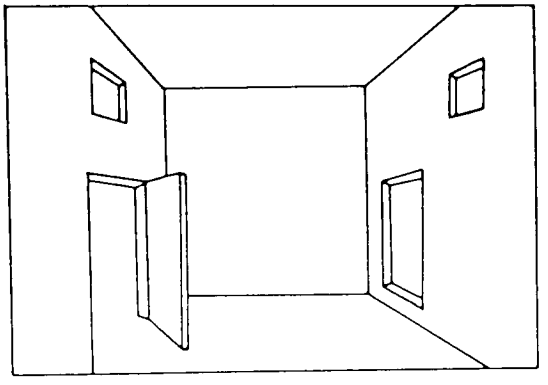
Scene 26: Court2.ani

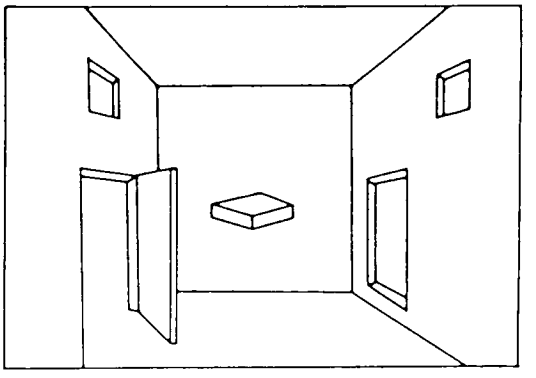
Here, through a shape transformation, a green rectangular shape moves across the scene, simulating a door closing on the view.



Scene 27: Room.ani

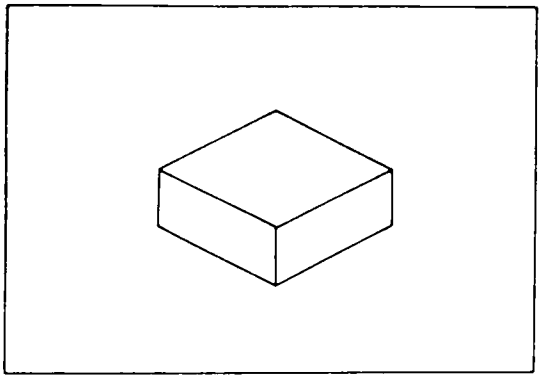
Scene 26 is then replaced with a view of a room interior framed in on a closed door. The room is brought into view by framing out. Then a box appears to enter through a window, although it was actually hidden by a wall-colored panel butted up to the window opening.

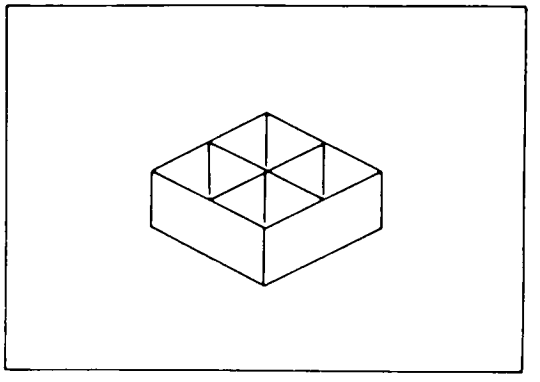




Scene 28: Room2.ani

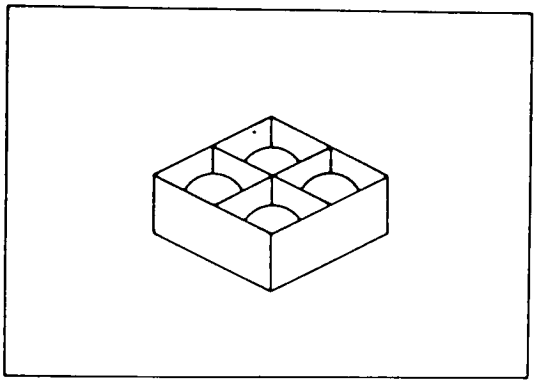
Once the box it positioned in the middle of the room, the doors and windows slowly shut. The doors appear to swing shut through shape transformations, while the windows shut by simply moving a square across them. The box is actually made up of many triangular pieces. By changing the colors of these pieces, various dimensional effects will be created in the later scenes. Here, through color transformations, it appears to change to a carton with four holes in the top.

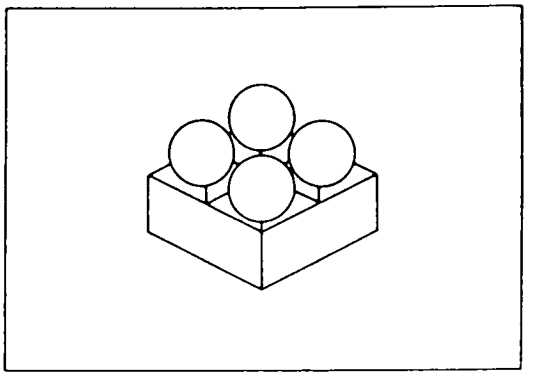




Scene 29: Eggs.ani

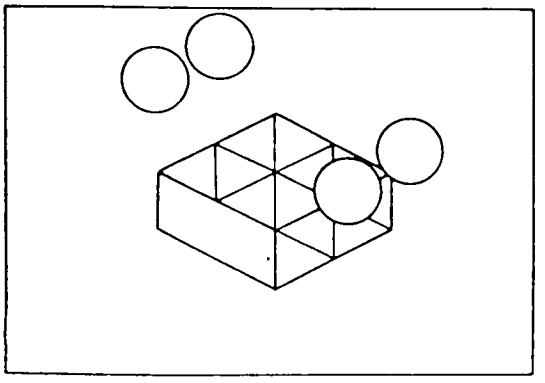
Here four spheres are situated behind the box and the objects making up the room are deleted. By correctly ordering the overlay, moving the spheres up in unison makes them appear to come out of the four holes.

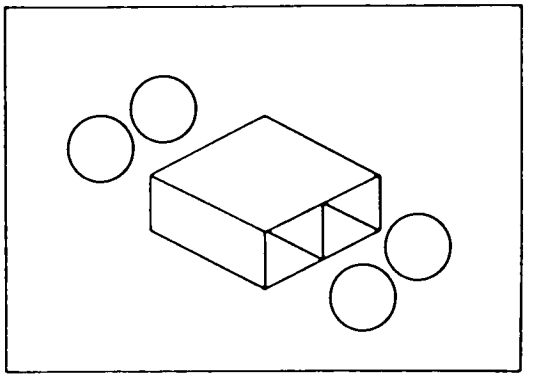




Scene 30: Eggs2.ani

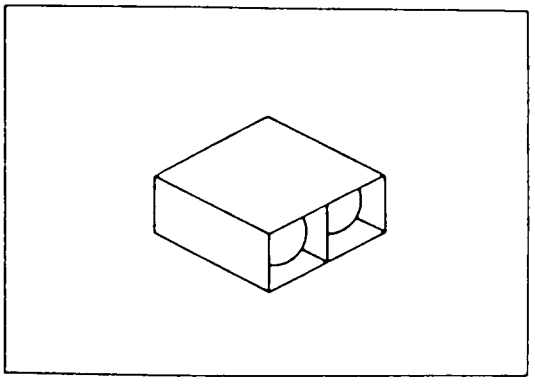
This scene, like the following ones, had to be created in order to rearrange the overlay so the spheres can move on different levels. The spheres here move in pairs to either side while a color change makes the top holes disappear and two holes in the side appear.

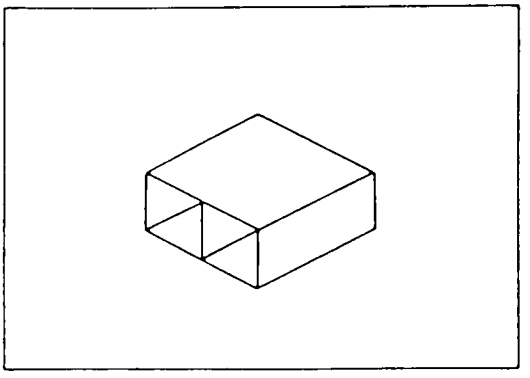




Scene 31: Eggs3.ani

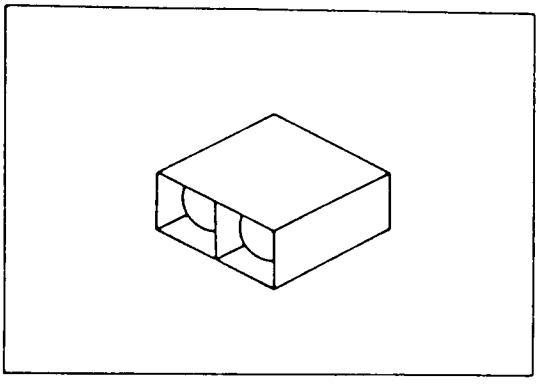
The spheres then move into the side openings. The colors change again, closing the two openings after the spheres enter and opening two new ones on the other side.

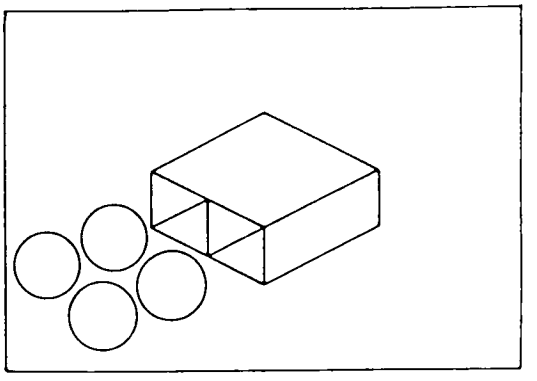




Scene 32: Eggs4.ani

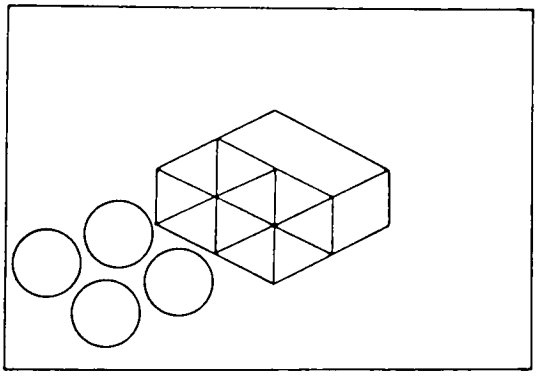
The balls then move out of the new side openings.

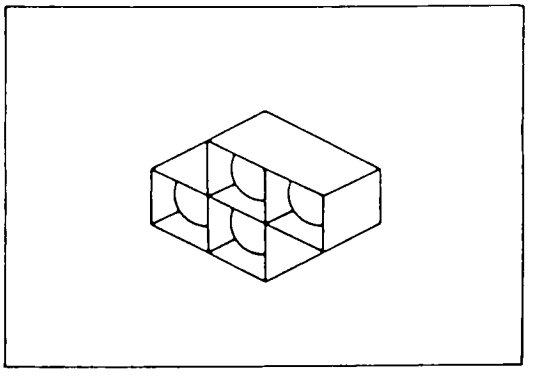




Scene 33: eggs5.ani

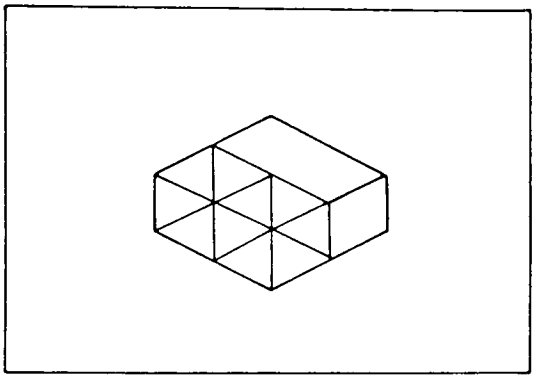
All of the previous color changes created openings in the cube, but did not imply any basic changes in its overall dimensions. This time when the colors change, they suggest an arrangement of holes that would not have been possible on the normal cube. The eye does not want to immediately adapt itself to this completely new shape however, and the new color arrangement does not at first seem to create any structure. It is all immediately put into concrete dimensions when the four spheres move into the new openings.

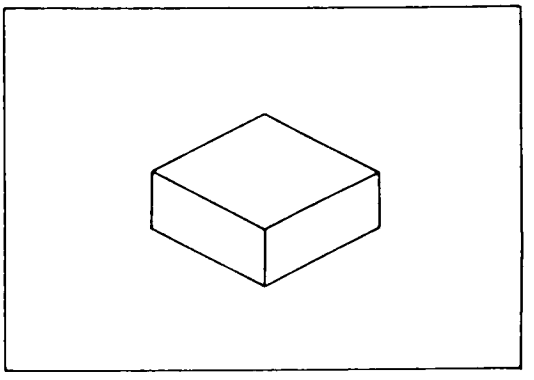




Scene 34: Bye.ani

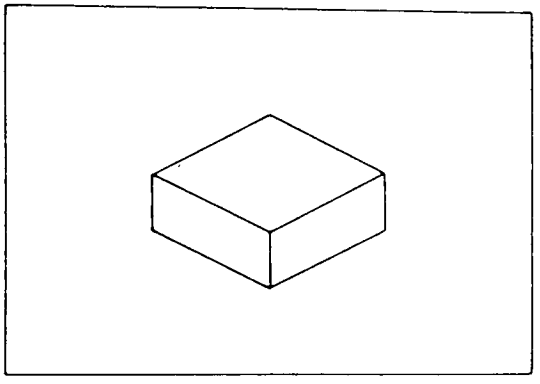
The now hidden spheres are removed from the scene and the box resumes its normal coloration without any openings.

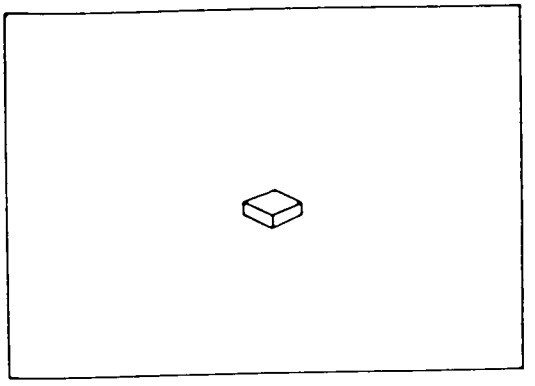




Scene 35: Bye2.ani

Through shape transformations applied to the group, the box seems to tilt back slightly and then disappear into space at the vanishing point.



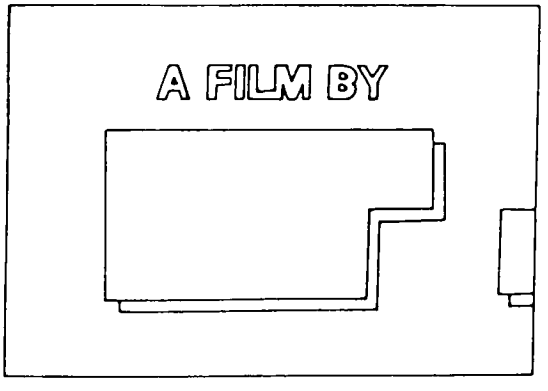


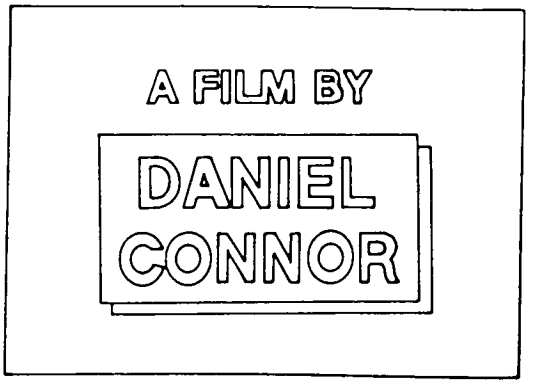
Scene 36: End.ani

The frame moves up and sideways to reveal the words "A FILM BY". The words are made to appear embossed by the coloration of outline letter forms. The outline font is actually made up of nine versions of the same letter, each slightly offset in a different direction with the letter occupying the center position the same color as the background.

Twelve squares then move on to the screen, one after another. Their movement is created by flopping the objects as they move. They are given added dimensionality by having their shadows move similarly.

The animator's name then appears, in rather large letters, on the rectangle formed by the squares. First it is moved over the rectangle from offscreen in two frames, and then the color of the type changes from that of the rectangle to a contrasting bright red.





APPENDIX

For those familiar with the Genigraphics animation system, the following pages provide table-dumps. These include detailed information about each individual scene and will aid in the further analysis of the films creation.

PAGE 1 GROUP.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	28	3	0.0
30	34	6	0.0
64	28	3	0.0
92	28	3	0.0
120	28	3	0.0
148	28	3	0.0
176	46	12	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
72	144	46	0	72	1	0	2	
2	MOVE							
72	144	46	0	72	1	0	30	
3	MOVE							
72	144	46	0	72	1	0	64	
4	MOVE							
72	144	46	0	72	1	0	92	
5	MOVE							
72	144	46	0	72	1	0	120	
6	MOVE							
60	144	46	0	84	1	0	148	
7	HCV COLOR							
1	50	204	0	49	1	0	176	

PAGE 1 CUBE.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	48	13	0.0
50	28	3	0.0
78	24	1	0.0
102	24	1	0.0
126	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	HCV COLOR							
24	26	218	0	2	1	0	2	
2	TRANSFORM							
1	24	236	0	23	1	0	50	
3	MOVE							
24	48	46	0	24	1	0	78	
4	MOVE							
24	48	46	0	24	1	0	102	
5	MOVE							
24	48	46	0	24	1	0	126	

PAGE 1 CUBE2.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	28	3	0.0
30	28	3	0.0
58	28	3	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
24	96	46	0	72	1	0	2	
2	MOVE							
24	96	46	0	72	1	0	30	
3	MOVE							
24	96	46	0	72	1	0	58	

PAGE 1 CUBE3.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	40	9	0.0
42	40	9	0.0
82	28	3	0.0
110	28	3	0.0
138	28	3	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	ORBIT							
1	12	54	0	11	1	0	2	0.38
2	MOVE							
12	24	46	0	12	1	0	2	
3	ORBIT							
1	24	54	0	23	1	0	42	0.25
4	MOVE							
24	72	46	0	48	1	0	82	
5	MOVE							
24	72	46	0	48	1	0	110	
6	MOVE							
24	72	46	0	48	1	0	138	

PAGE 1 CUBE4.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	32	5	0.0
34	24	1	0.0
58	44	11	0.0
102	28	3	0.0
130	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	24	46	0	23	1	0	2	
2	TRANSFORM							
1	24	136	0	23	1	0	34	
3	HCV COLOR							
20	24	50	0	4	1	0	34	
5	MOVE							
12	96	46	0	84	1	0	102	
6	MOVE							
24	30	46	0	6	1	0	34	
4	TRANSFORM							
18	80	624	0	62	1	0	58	
7	MOVE							
22	68	46	0	46	1	0	58	
8	TRANSFORM							
40	50	124	0	10	1	0	130	
9	TRANSFORM							
30	40	124	0	10	1	0	130	
10	TRANSFORM							
80	85	124	0	5	1	0	130	

PAGE 1 GEO.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	72	25	0.0
74	32	5	0.0
106	28	3	0.0
134	40	9	0.0
174	40	9	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	HCV COLOR							
1	48	386	0	47	1	0	2	
3	MOVE							
48	120	46	0	72	1	0	74	
5	HCV COLOR							
48	72	106	0	24	1	0	74	
6	HCV COLOR							
72	96	78	0	24	1	0	106	
7	HCV COLOR							
96	120	78	0	24	1	0	106	
2	TRANSFORM							
48	120	336	0	72	1	0	74	
8	ROTATE							
48	120	214	0	72	1	0	74	-1.0
9	ORBIT							
100	120	54	0	20	1	0	134	0.24
10	TRANSFORM							
100	120	308	0	20	1	0	134	
11	ORBIT							
95	120	54	0	25	1	0	174	0.38
12	TRANSFORM							
95	120	308	0	25	1	0	174	

PAGE 1 ISLAND.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	32	5	0.0
34	30	4	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
2	MOVE							
36	48	46	0	12	1	0	2	
3	MOVE							
36	48	46	0	12	1	0	34	
1	FRAME							
1	36	54	0	35	1			

PAGE 1 ISLAND2.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	34	6	0.0
36	28	3	0.0
64	28	3	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	36	46	0	35	1	0	2	
2	MOVE							
30	48	46	0	18	1	0	36	
3	MOVE							
30	48	46	0	18	1	0	64	
4	TRANSFORM							
40	84	446	0	44	1	0	2	
5	FRAME							
40	84	54	0	44	1			

PAGE 1 BOXES5.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	24	1	0.0
26	24	1	0.0
50	24	1	0.0
74	26	2	0.0
100	26	2	0.0
126	26	2	0.0
152	40	9	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	48	124	0	47	1	0	2	
2	TRANSFORM							
1	48	124	0	47	1	0	26	
3	TRANSFORM							
1	48	124	0	47	1	0	50	
5	TRANSFORM							
40	96	198	0	56	1	0	74	
6	TRANSFORM							
40	96	198	0	56	1	0	100	
7	TRANSFORM							
40	96	198	0	56	1	0	126	
8	HCV COLOR							
90	120	162	0	30	1	0	152	

PAGE 1 LOCK.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	72	25	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
2	HCV COLOR							
48	120	386	0	72	1	0	2	
3	TRANSFORM							
120	200	1660	0	80	1	0	2	
4	FRAME							
120	200	54	0	80	1			
1	RGB COLOR							
1	48	386	0	47	1	0	2	

PAGE 1 BOXES3.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	64	21	0.0
66	24	1	0.0
90	28	3	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	36	1352	0	35	1	0	2	
2	MOVE							
1	36	46	0	35	1	0	2	
3	HCV COLOR							
1	36	50	0	35	1	0	66	
4	MOVE							
40	96	46	0	56	1	0	90	

PAGE 1 BOXES4.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	24	1	0.0
26	24	1	0.0
50	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	48	46	0	47	1	0	2	
2	TRANSFORM							
1	48	124	0	47	1	0	2	
3	TRANSFORM							
1	48	160	0	47	1	0	26	
4	TRANSFORM							
1	48	148	0	47	1	0	50	

PAGE 1 ARCH.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	40	9	0.0
42	26	2	0.0
68	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	RGB COLOR							
1	48	129	0	47	1	0	2	
2	RGB COLOR							
48	72	50	0	24	1	0	42	
3	TRANSFORM							
48	200	124	0	152	1	0	68	

PAGE 1 BALLS.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	0	0	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	FRAME							
1	48	54	0	47	1			

PAGE 1 BALLS2.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	70	24	0.0
72	70	24	0.0
142	70	24	0.0
212	70	24	0.0
282	68	23	0.0
350	24	1	0.0
374	28	3	0.0
402	28	3	0.0
430	28	3	0.0
458	28	3	0.0
486	28	3	0.0
514	52	15	0.0
566	260	119	0.0
826	74	26	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	48	46	0	47	1	0	2	
2	MOVE							
1	48	46	0	47	1	0	72	
3	MOVE							
1	48	46	0	47	1	0	142	
4	MOVE							
1	48	46	0	47	1	0	212	
5	MOVE							
1	48	46	0	47	1	0	282	
6	MOVE							
1	2	46	0	1	1	0	350	
7	MOVE							
1	48	46	0	47	1	0	374	
8	MOVE							
1	48	46	0	47	1	0	402	
9	MOVE							
1	48	46	0	47	1	0	430	
10	MOVE							
1	48	46	0	47	1	0	458	
11	MOVE							
1	48	46	0	47	1	0	486	
12	HOV COLOR							
1	35	50	0	34	1	0	514	
14	MOVE							
1	48	46	0	47	1	0	566	
13	TRANSFORM							
48	96	3168	0	48	1	0	566	
16	TRANSFORM							
96	130	894	0	34	1	0	826	
17	HOV COLOR							
110	140	204	0	30	1	0	826	

PAGE 1 PYRA.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	46	12	0.0
48	102	40	0.0
150	24	1	0.0
174	26	2	0.0
200	30	4	0.0
230	26	2	0.0
256	30	4	0.0
286	24	1	0.0
310	24	1	0.0
334	24	1	0.0
358	24	1	0.0
382	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	72	46	0	71	1	0	2	
2	MOVE							
1	72	46	0	71	1	0	48	
3	TRANSFORM							
65	120	124	0	55	1	0	150	
4	MOVE							
84	285	46	0	201	1	0	174	
5	MOVE							
84	285	46	0	201	1	0	200	
6	MOVE							
105	305	46	0	200	1	0	230	
7	MOVE							
105	305	46	0	200	1	0	256	
8	ROTATE							
84	285	102	0	201	1	0	174	0.10
9	ROTATE							
84	285	174	0	201	1	0	200	0.20
10	ROTATE							
105	305	102	0	200	1	0	230	0.16
11	ROTATE							
105	305	174	0	200	1	0	256	0.16
12	HCV COLOR							
84	285	50	0	201	1	0	286	
13	HCV COLOR							
84	285	50	0	201	1	0	310	
14	HCV COLOR							
105	305	50	0	200	1	0	334	

PAGE 1 BLUE.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	62	20	0.0
64	62	20	0.0
126	24	1	0.0
150	102	40	0.0

ENTRY#	TYPE							
START	FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	240	690	0	239	7	0	2	
2	ORBIT							
1	240	54	0	239	1	0	2	3.0
3	TRANSFORM							
1	40	594	0	39	1	0	2	
4	TRANSFORM							
40	80	594	0	40	1	0	2	
5	TRANSFORM							
80	120	594	0	40	1	0	2	
6	TRANSFORM							
120	160	594	0	40	1	0	2	
7	TRANSFORM							
160	200	594	0	40	1	0	2	
8	TRANSFORM							
200	240	594	0	40	1	0	2	
9	TRANSFORM							
1	240	690	0	239	7	0	64	
10	ORBIT							
1	240	54	0	239	1	0	64	3.0
11	TRANSFORM							
1	40	594	0	39	1	0	64	
12	TRANSFORM							
40	80	594	0	40	1	0	64	
13	TRANSFORM							
80	120	594	0	40	1	0	64	
14	TRANSFORM							
120	160	594	0	40	1	0	64	
15	TRANSFORM							
160	200	594	0	40	1	0	64	
16	TRANSFORM							
200	240	594	0	40	1	0	64	
17	FRAME							
80	240	54	0	160	1			
18	MOVE							
80	240	46	0	160	1	0	126	
19	TRANSFORM							
210	240	1114	0	30	1	0	150	

PAGE 1 ALTAR.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	60	19	0.0
62	62	20	0.0
124	100	39	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	FRAME							
1	72	54	0	71	1			
2	TRANSFORM							
72	90	568	0	18	1	0	2	
3	MOVE							
72	120	46	0	48	1	0	2	
4	TRANSFORM							
72	110	594	0	38	1	0	62	
5	MOVE							
72	130	46	0	58	1	0	62	
6	MOVE							
71	72	46	0	1	1	0	124	
7	FRAME							
1	72	54	0	71	1			

PAGE 1 ALTAR2.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	40	9	0.0
42	26	2	0.0
68	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	48	428	0	47	1	0	2	
2	MOVE							
1	48	46	0	47	1	0	2	
3	HCV COLOR							
1	48	64	0	47	1	0	42	
4	HCV COLOR							
46	54	50	0	8	1	0	68	
6	TRANSFORM							
72	96	428	0	24	1	0	2	
7	HCV COLOR							
72	90	50	0	18	1	0	68	
8	FRAME							
96	160	54	0	64	1			
9	MOVE							
97	98	46	0	1	1	0	2	

PAGE 1 PIT.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	34	6	0.0
36	30	4	0.0
66	26	2	0.0
92	34	6	0.0
126	102	40	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REQS
1	RGB COLOR							
1	36	78	0	35	1	0	2	
2	MOVE							
30	120	46	0	90	1	0	36	
3	MOVE							
90	120	46	0	30	1	0	66	
4	RGB COLOR							
120	140	78	0	20	1	0	92	
5	MOVE							
140	200	46	0	60	1	0	126	
6	MOVE							
140	141	46	0	1	1	0	66	
7	FRAME							
140	200	54	0	60	1			

PAGE 1 PIT2.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REQS
1	TRANSFORM							
1	48	124	0	47	1	0	2	

PAGE 1 FOLD.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	34	6	0.0
36	34	6	0.0
70	24	1	0.0
94	26	2	0.0
120	26	2	0.0
146	24	1	0.0
170	24	1	0.0
194	24	1	0.0
218	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	96	374	0	95	1	0	2	
2	FRAME							
1	96	54	0	95	1			
3	ROTATE							
48	96	246	0	48	1	0	36	0.12
4	TRANSFORM							
96	120	374	0	24	1	0	36	
5	TRANSFORM							
120	172	124	0	52	1	0	70	
6	HCV COLOR							
120	172	50	0	52	1	0	70	
7	TRANSFORM							
130	182	174	0	52	1	0	94	
8	HCV COLOR							
130	182	64	0	52	1	0	120	
9	TRANSFORM							
182	220	124	0	38	1	0	146	
10	HCV COLOR							
182	200	50	0	18	1	0	146	
11	HCV COLOR							
200	220	50	0	20	1	0	146	
12	TRANSFORM							
140	192	124	0	52	1	0	170	
13	HCV COLOR							
140	192	50	0	52	1	0	170	
14	HCV COLOR							
120	200	50	0	80	1	0	194	
15	TRANSFORM							
150	202	124	0	52	1	0	218	
16	TRANSFORM							
220	250	374	0	30	1	0	36	

PAGE 1 STAR.ANI

ANIMATION TABLE
28-MAR-86

GROUP#	SIZE	#OBJS	ANGLE
2	36	7	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	72	532	0	71	1	0	2	
2	HCV COLOR							
10	72	134	0	62	1	0	2	

PAGE 1 FLASH.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	36	7	0.0
38	24	1	0.0
62	26	2	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	HCV COLOR							
1	50	134	0	49	1	0	2	
2	TRANSFORM							
1	72	124	0	71	1	0	38	
3	TRANSFORM							
1	72	532	0	71	1	0	2	
4	TRANSFORM							
72	120	126	0	48	1	0	62	
5	HCV COLOR							
72	100	64	0	28	1	0	62	
6	HCV COLOR							
100	120	64	0	20	1	0	62	
7	MOVE							
73	74	46	0	1	1	0	2	
8	TRANSFORM							
120	172	124	0	52	1	0	38	
9	HCV COLOR							
120	172	50	0	52	1	0	38	

PAGE 1 COURT.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	26	2	0.0
28	26	2	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
2	TRANSFORM							
1	10	174	0	9	1	0	2	
1	FRAME							
10	120	54	0	110	1			
3	HCV COLOR							
30	130	64	0	40	1	0	28	

PAGE 1 COURT.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	24	1	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	48	124	0	47	1	0	2	

PAGE 1 ROOM.ANI

ANIMATION TABLE
30-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	54	16	0.0
56	32	5	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	FRAME							
1	100	54	0	99	1			
2	MOVE							
125	150	46	0	25	1	0	2	
3	MOVE							
100	135	46	0	35	1	0	2	
4	TRANSFORM							
110	140	682	0	30	1	0	2	
5	HCV COLOR							
120	200	64	0	80	1	0	56	

PAGE 1 ROOM2.ANI

ANIMATION TABLE
28-MAR-88

GROUP#	SIZE	#OBJS	ANGLE
2	30	4	0.0
32	24	1	0.0
56	24	1	0.0
80	28	3	0.0
108	28	3	0.0
136	24	1	0.0
160	54	16	0.0
214	28	3	0.0
242	26	2	0.0
268	28	3	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	50	274	0	49	1	0	2	
2	HCV COLOR							
21	22	50	0	1	1	0	32	
3	HCV COLOR							
1	50	50	0	49	1	0	56	
4	TRANSFORM							
10	70	224	0	60	1	0	80	
5	TRANSFORM							
1	2	124	0	1	1	0	136	
6	TRANSFORM							
70	120	682	0	50	1	0	160	
7	HCV COLOR							
70	120	50	0	50	1	0	214	
8	HCV COLOR							
70	120	50	0	50	1	0	242	
9	HCV COLOR							
70	120	64	0	50	1	0	268	
10	HCV COLOR							
120	140	260	0	20	1	0	160	

PAGE 1 EGGS.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	102	40	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	48	46	0	47	1	0	2	

PAGE 1 EGGS2.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	62	20	0.0
64	62	20	0.0
126	54	16	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	40	46	0	39	1	0	2	
2	MOVE							
25	40	46	0	15	1	0	2	
3	MOVE							
1	40	46	0	39	1	0	64	
4	MOVE							
25	40	46	0	15	1	0	64	
5	HCV COLOR							
1	40	260	0	39	1	0	126	

PAGE 1 EGGS3.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	62	20	0.0
64	62	20	0.0
126	54	16	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	36	46	0	35	1	0	2	
2	MOVE							
1	36	46	0	35	1	0	64	
3	HCV COLOR							
36	60	260	0	24	1	0	126	

PAGE 1 EGGS4.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	102	40	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	MOVE							
1	36	46	0	35	1	0	2	

PAGE 1 EGGS5.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	54	16	0.0
56	102	40	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	HCV COLOR							
1	36	260	0	35	1	0	2	
2	MOVE							
36	80	46	0	44	1	0	56	

PAGE 1 BYE.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	54	16	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	HCV COLOR							
1	30	260	0	29	1	0	2	

PAGE 1 BYE2.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	28	3	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	TRANSFORM							
1	36	224	0	35	1	0	2	
2	TRANSFORM							
24	80	224	0	56	1	0	2	

PAGE 1 END.ANI

ANIMATION TABLE
29-APR-74

GROUP#	SIZE	#OBJS	ANGLE
2	24	1	0.0
26	26	2	0.0
52	26	2	0.0
78	26	2	0.0
104	26	2	0.0
130	26	2	0.0
156	26	2	0.0
182	26	2	0.0
208	26	2	0.0
234	26	2	0.0
260	26	2	0.0
286	26	2	0.0
312	26	2	0.0
338	30	4	0.0
368	78	28	0.0
446	78	28	0.0

ENTRY# START	TYPE FINISH	SIZE	CYCLE	ACTIVE	#PTS		GROUP	#REVS
1	FRAME							
1	80	54	0	79	1			
2	HCV COLOR							
1	40	50	0	39	1	0	2	
3	TRANSFORM							
80	100	174	0	20	1	0	26	
4	TRANSFORM							
85	105	174	814	20	1	530	52	
5	TRANSFORM							
90	110	174	0	20	1	0	78	
6	TRANSFORM							
95	115	174	0	20	1	0	104	
7	TRANSFORM							
100	120	174	0	20	1	0	130	
8	TRANSFORM							
105	125	174	0	20	1	0	156	
9	TRANSFORM							
110	130	174	0	20	1	0	182	
10	TRANSFORM							
115	135	174	0	20	1	0	208	
11	TRANSFORM							
120	140	174	0	20	1	0	234	
12	TRANSFORM							
125	145	174	0	20	1	0	260	
13	TRANSFORM							
130	150	174	0	20	1	0	286	
14	TRANSFORM							
135	155	174	0	20	1	0	312	
15	MOVE							
155	156	46	0	1	1	0	338	
16	HCV COLOR							
156	185	78	0	29	1	0	338	
17	TRANSFORM							
185	230	1474	0	45	1	0	368	
18	HCV COLOR							
190	230	260	0	40	1	0	446	